2.3 Value of Millimetre Wave Ownership

In addition to the characteristics of low cost of ownership and low cost of installation/commissioning, another element of cost-effectiveness of digital millimetre wave radio is the payback period.The payback period is the time the equipment takes to repay itself, in terms of the monthly cost of leased digital signal transmission services, leased E1 services, offered by carriers. This payback period figure puts into perspective the value that can be realized by owning a digital signal transmission infrastructure.

The international rates for leasing digital transmission services vary within a wide range. One of the least expensive regions is the United Kingdom (UK), due to the high degree of competition brought about by deregulation and privatisation.

Approximate annual lease costs in the UK for 4E1s over a 5 km distance are as follows:

Connection Charge:	$ 23,100.00
Fixed Annual Rental Charge:	$ 22,200.00
Annual Rental - 5 km:	$ 4,950.00
Total	$ 50,250.00/year, or,
	$ 4,200.00/month

Note: Figures given are based on UK published rates July-92.

Based on these figures, at an average installed 4E1 millimetre wave radio link installed cost of $20,000.00, it becomes clear that a link of 4E1 radio will pay for itself in less than six (6) months. Besides cost savings, there are other attractive benefits to owning the digital transmission segments of the telecommunications infrastructure. The owner can control all aspects of the radio system, such as the service coverage area, bandwidth allocation and network management. The user can realize an increase in reliability, and even control the system reliability, thereby disproving the myth that leased services are more reliable than millimetre wave radio. Finally, the user can re-lease unused bandwidth to realize additional economic benefits and efficient operation of the system.

The payback period of millimetre wave radio, together with the other components of cost savings, combine to create an attractive solution for organizations that are interested in owning their digital transmission infrastructure. In addition, the owner can control all aspects of the system operation, and realize profitable and efficient operation.

2.4 Role in Emerging Technologies

An important element of the current European Global System for Mobile Communications (GSM) programme is the creation of a Pan-European roaming capability, over the existing cellular networks. In addition to standardisation, the GSM programme seeks to achieve other objectives such as:

- Reliable RF transmission
- High quality digital data transmission
- Link integrity
- System security
- Other enhanced features

The above objectives are being met while integrating the nearly two dozen existing cellular networks. When realising these objectives, cost containment is also an objective of the GSM programme.

Since network standardisation is becoming a reality, another element of the GSM programme must be considered. This element is the interface of the Pan-European standard wireless network with the existing non-wireless, or land-line, network. As an extension of the land-line network, the GSM network must provide the same digital services as the highly digital land-line network. Offering these digital services to the subscriber requires that the GSM network be equipped with cost-effective digital transmission capability.

One technology that is being considered by the GSM programme, in an attempt to realise the desired cost-effectiveness, is digital Air Interface Technology (AIT refers to the method of RF transmission between the cellular company's base station and the subscriber's telephone). Code Division Multiple Access (CDMA) and Time Division Multiple Access (TDMA) are digital Air Interface Technologies that allow the cellular network operator to provide reliable service, while achieving economies of scale. With respect to reliability, these digital techniques exhibit a notable performance increase in base station receiver sensitivity. With respect to cost-effectiveness, CDMA and TDMA use the RF spectrum more efficiently, approximately eight times more efficient than traditional analog AITs. Of course, an increase of spectral efficiency of this magnitude allows the cellular network operator to realise a proportional increase in quantity of subscribers. And for the service provider, additional subscribers results in higher revenues.

The transport of the subscriber traffic from the digital AIT environment to the base switching environment requires Digital Data Transmission technology, another important technology. Digital Data Transmission via digital millimetre wave radio is a cost-effective method for achieving subscriber traffic transport. Millimetre wave radios, such as the Tel-Link Series provided by P-Com, designed with this technology, transport one or more digital data signals at the standard rate of 2.048 Mb/s. Millimetre wave radios transmit these standard digital data signals by modulating them on to an RF carrier in the frequency range of 23 to 55 GHz. This carrier forms a point-to-point RF path between each end of the radio link, which "carries" the digital transmission signal. Digital millimetre wave radios contribute to cost-effectiveness due to their inherent flexibility. The physical placement of a terminal of digital millimetre wave radio has no limitations, except for known obstructions. The low cost of ownership, due to low installation, maintenance and spares costs, is another contribution to cost-effectiveness. In summary, the Tel-Link Series of radios are cost-effective solutions to digital transmission challenges that have arisen in today's telecommunications environment.

Digital Air Interface Technologies and digital millimetre wave radio technology are envisioned as necessary for service providers to consider while planning to fulfil infrastructure requirements of the modern cellular networks. Service providers will be required to integrate emerging technologies, such as these, so the increasingly sophisticated users of today will receive the three-dimensional service that they demand. The high quality, three-dimensional services that are available to the subscriber independent of subscriber location include indoor, outdoor or underground. Use of digital millimetre wave radio, such as the P-Com Tel-Link, facilitates the improvement and expansion of existing infrastructure. Digital millimetre wave radio is an attractive alternative due to its inherent flexibility and cost-effective implementation.

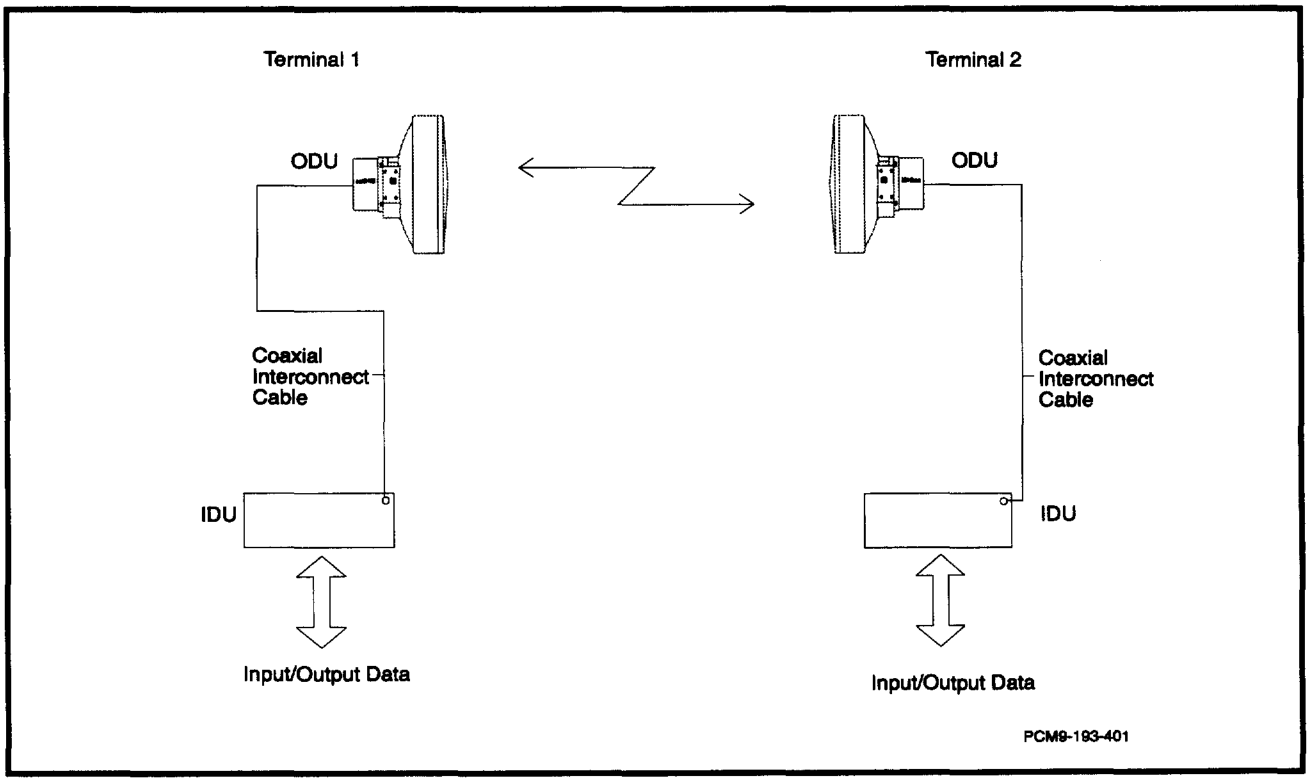
3.0 Product Description

3.1 Product Overview

Each P-Com terminal consists of an Indoor Unit (IDU) and an Outdoor Unit (ODU) interconnected by a single coaxial cable. The ODU assembly includes both the radio unit (RF) and a parabolic antenna. The radio electronics portion can be easily connected and disconnected from the antenna for installation and maintenance purposes; this is a quick release mechanism requiring no special tools or hardware. The antenna includes a pole mounting assembly as well as adjustments for vertical or horizontal polarisation and coarse and fine antenna alignment. Removing or replacing of the radio electronics from the antenna does not require realignment of the antenna. The IDU is a standard rack-mountable shelf unit which provides multiplexing/demultiplexing and other signal processing functions. This includes the digital modulation/demodulation of an intermediate frequency carrier that is transmitted/received through the IF coaxial cable to/from the ODU.

Installation requires first attaching the antenna mount to the pole and then attaching the antenna to the mount in the approximate visual direction of the antenna at the opposite end of the system. After both antennas have been mounted and approximately aligned, the radio electronics enclosure (ODU) is electrically and mechanically mated to the antenna by simply fastening the four quick release latches provided on the perimeter of the radio electronics enclosure. Following the mounting of both the ODU and IDU, the coaxial cable is connected at both locations with "N" type connectors. The entire terminal is powered up by turning on the power at the IDU. With the power on, the antenna is finely aligned by panning both elevation and azimuth until the received signal level (RSL) is maximised as indicated

Figure 3.1 – P-Com Tel-Link Radio System



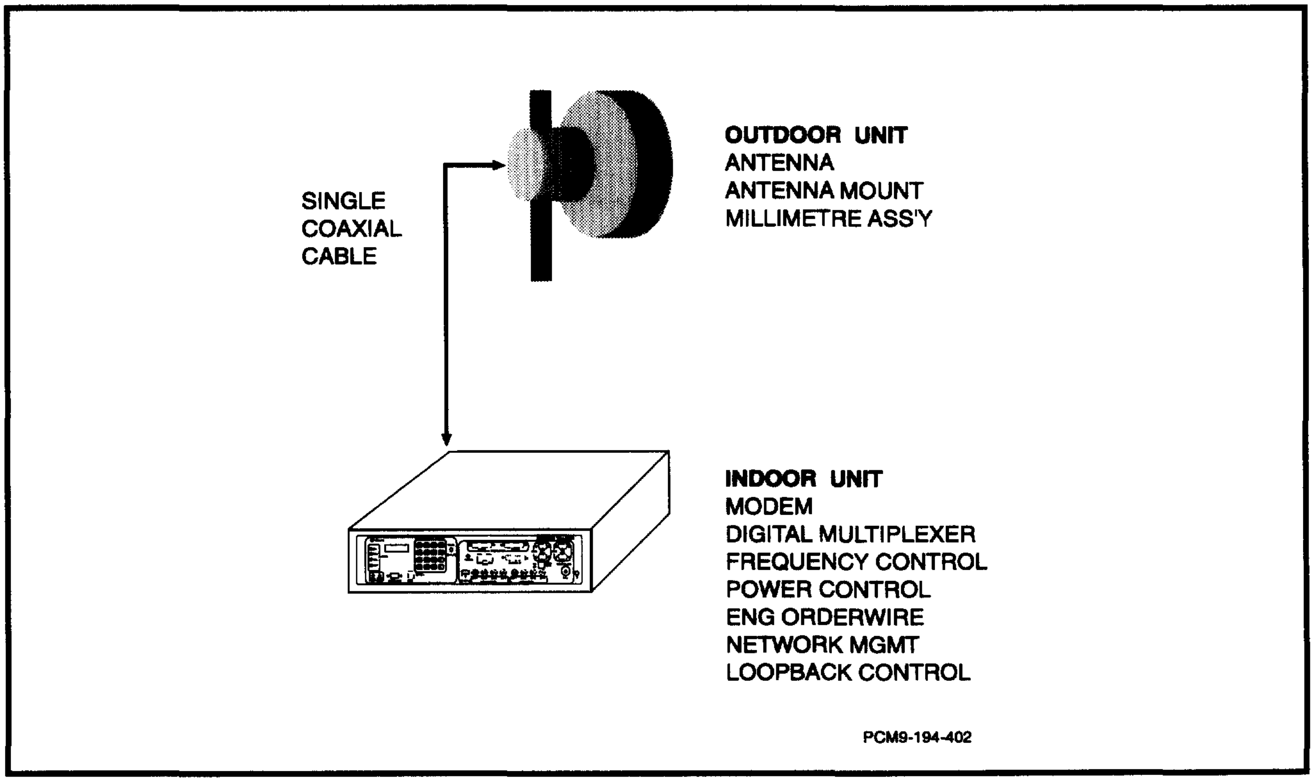
through a voltmeter connected to the RSL monitor point on the ODU (BNC connector). Once this procedure has been completed on both ends of the system, the link is ready for operation.

3.2 Theory of Operation

The primary purpose of the P-Com Tel-Link radio equipment is to provide a reliable and cost-effective communications link of digital capacity ranging from 2 to 8 Mb/s over a short distance. Cost-effectiveness is achieved by adopting efficient technological solutions which: a) make the equipment intrinsically low in material and labour cost, and, b) minimise the user's cost of ownership including installation, operation and maintenance. Because of its unique integrated millimetre wave technology, the Tel-Link Series of Radios are extremely economical relative to other products on the market. This technology reduces the required number of discrete components and eliminates many of the precision mechanical waveguide interfaces.

With minimising the end user's cost of ownership as the ultimate target, the system architecture is such that the ODU has been designed with the minimum amount of functions, and therefore components. In pursuit of the highest possible reliability for the outdoor mounted unit (ODU), all necessary or desirable flexibility features have been incorporated into the IDU where operation is in a controlled and easily accessible environment. With P-Com's Tel-Link radio equipment, even significant modifications such as power output, frequency and capacity changes are controlled from the IDU and, thus, simple and economical for the user. Figure 3.2 illustrates this product philosophy.

Figure 3.2 – Tel-Link Millimetre Wave Terminal



Refer to the simplified system block diagram in Figure 3.3 for understanding of the following signal flow description. In the transmit direction, a standard G.703 data signal (2-8 Mb/s) is inputted to the IDU. Within the IDU, the G.703 signal is converted to a Non-Return-to-Zero (NRZ) format by line interface circuitry. The signal is then digitally multiplexed, Frequency Shift Key (FSK) modulated on an Intermediate Frequency (IF) carrier and delivered to the coaxial cable input for transmission to the ODU. The ODU upconverts the transmit IF signal to the desired final RF transmit frequency. This frequency is then radiated through the antenna to the remote end terminal. In the receive direction, the millimetre wave signal is received at the antenna of the receiving terminal, downconverted by the ODU to the receive IF frequency and delivered to the ODU port of the IF coaxial cable. The receive IF signal, through the coaxial cable between the ODU and IDU, enters the IDU where it is FSK demodulated, demultiplexed and finally converted to the standard G.703 signal. This digital signal is then output from the IDU to the user's site equipment.

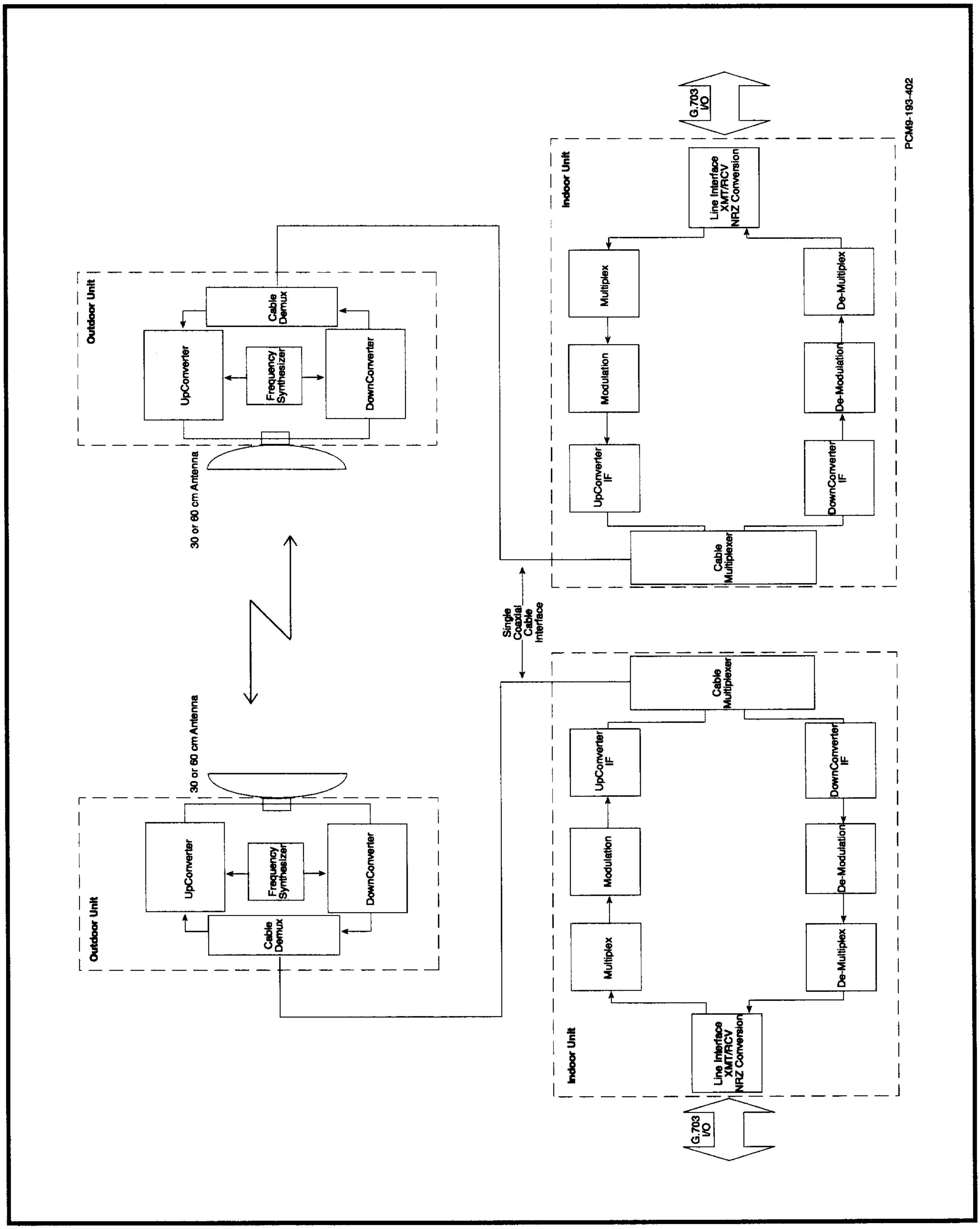
The ODU/Antenna assembly contains the technological advancements that make the Tel-Link product a unique offering to the market. The nature of this technology results in RF electronics that are small in size, light in weight, low in power consumption, high in reliability and low in cost. This integrated RF electronics enclosure attaches to an antenna with a diameter of 30 or 60 cm. The ODU is, typically, installed outdoors on a tower or rooftop. Because of its remote location, the ODU only contains the electronics that are required to be collocated with the antenna for reasons of either cost or path reliability. All other electronics reside in the IDU where performing maintenance functions is easier. Consistent with this philosophy, the ODU interfaces with the IDU at IF frequencies. One (1) RG8 type coaxial cable carries both transmit and receive IF carriers as well as power, telemetry and alarm signals.

The Tel-Link Radio is inherently more reliable than other products on the market. This product architecture results in better stability and immunity to phase hits and microphony caused by harsh outdoor environments. Also, due to the high level of integration in the ODU and reduced number of interconnections between modules, there is a built-in mechanical resistance to the shock and vibration that is inevitable in outdoor installation environments. This simple but effective approach to frequency generation together with very low power consumption (less heat dissipation) in the ODU and less discrete components all work together to result in a product that exhibits both electrical and mechanical designed-in reliability characteristics.

The IDU is an indoor mounted shelf or module depending upon which mounting option is desired. The IDU can be mounted within the customer's site equipment or as a stand alone unit in a standard relay rack. Power, orderwire, alarm, maintenance and network management system (NMS) interfaces also occur at the IDU. Because no bit rate sensitive components reside in the ODU, increases in capacity (i.e. E1 to 4E1) are easily accommodated merely by changing the IDU. No change in the ODU is necessary as all IF frequencies remain the same. In addition, any IDU can be used with any ODU since no unique ODU-IDU pairing is required.

Each radio terminal is provided with an Installation Kit (IK). The IK contains the Operations and Maintenance Manual as well as other miscellaneous hardware required for the installation and operation of the Tel-Link radio terminal. Only a simple voltmeter is required (for monitoring receive signal level when aligning the antennas) in addition to what P-Com provides as its standard product offering. The radio is designed to require no tuning or adjustments prior to the commissioning of the system.

Figure 3.3 – Simplified System Block Diagram



3.3 Product Features

The Tel-Link Radio has numerous valuable product features that minimise the user's cost of ownership (life cycle cost).

a) Loopback Capability:

The Tel-Link Radio has four (4) levels of loopback; IDU Loopback– this loops the signal back in the local IDU right before the coax interface and is traffic affecting; ODU Loopback– this loops the signal back in the local ODU, requires a loopback translator and is traffic affecting; LINK Loopback– this loops the signal back in the remote IDU right before the receive output to the user equipment and is only traffic affecting on the particular tributary chosen by the user to carry the test (traffic affecting in single tributary systems). Line loopback– loops the local E1 tributary at its interface to the IDU. This may be used to test the customer's equipment and wiring to the IDU. By using one or all of these loopback functions, the user is able to easily deduce whether the system problem is in the local or remote IDU or ODU, or in the path.

b) Single IDU-to-ODU Coax:

One cable carries all signals and power. This saves in material and installation costs and minimises the possibility of a faulty connection.

c) Convenient and Simple Sparing:

Sparing is at the highest possible level without sacrificing commonalty across frequency bands (IDU) and across bit rates (ODU). Replacing a faulty unit does not require the use of any tools, thus minimising the user's downtime when an equipment failure occurs. No special training is required for the replacement of faulty equipment and the reinstatement of the communications link. Again, any IDU can be installed with any ODU and the system will still perform to full specification.

d) Network Management:

All systems have the capability for interfacing with a network management system (NMS). This interface may be to an existing NMS or to P-Com's NMS. This interface capability is designed such that different options of NMS interface are compatible with the same basic IDU. The NMS provides alarm and configuration control as well as performance monitoring over an infinite number of radio links. Diagrams depicting an NMS configuration and NMS functions are provided in Figures 3.4 and 3.5 respectively.

e) Link ID:

Each IDU has the capability of setting a 2-digit ID code. There are 99 possible link IDs. The same code must be set on both local and remote IDUs in order for the link to pass data. Since all links in a particular geographic area will have different ID codes, this feature prevents a receiver locking up to an unwanted transmitter when the wanted transmitter has failed. If desired, the user may use the first digit of the 2-digit code as a region identifier and the second digit as a unique link identifier. The same 2-digit code can be reused provided that two links with the same code are installed far enough apart that there is no potential for interference (confirmed by standard frequency coordination practice).

Figure 3.4 – NMS Configuration

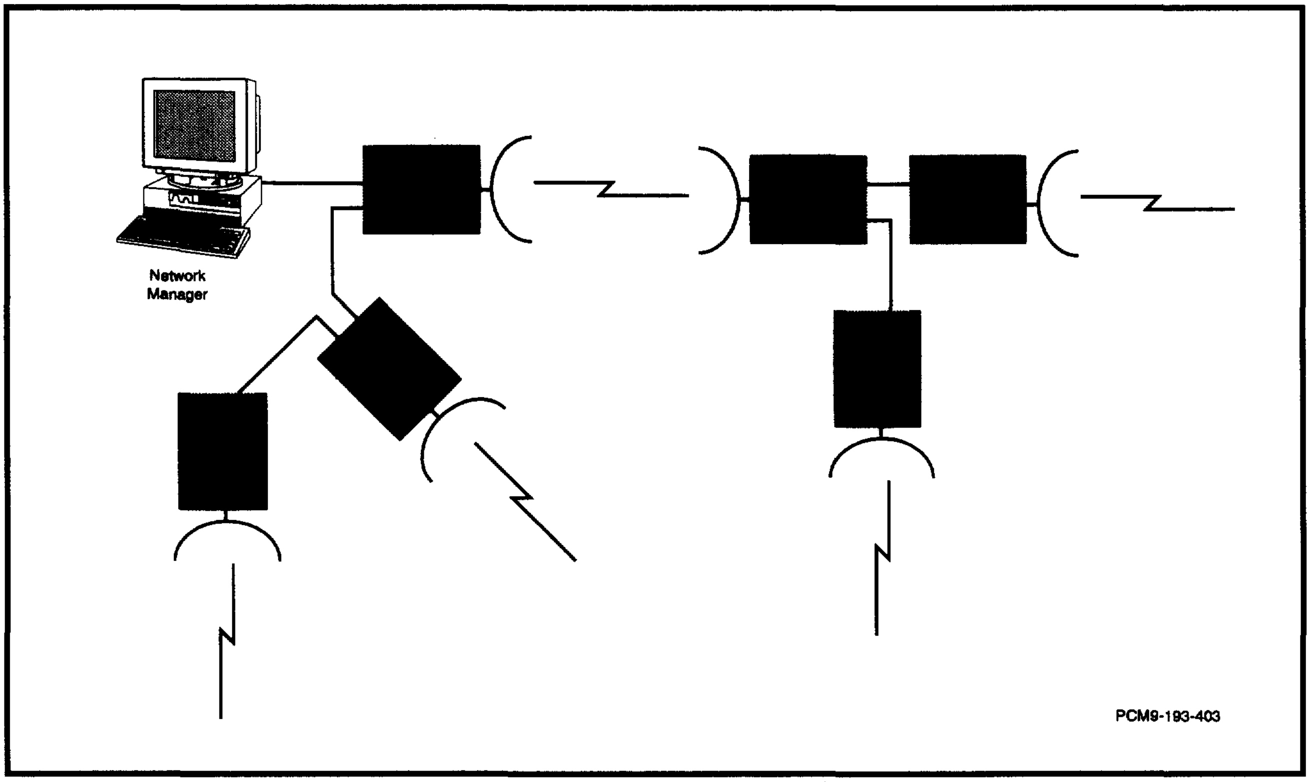
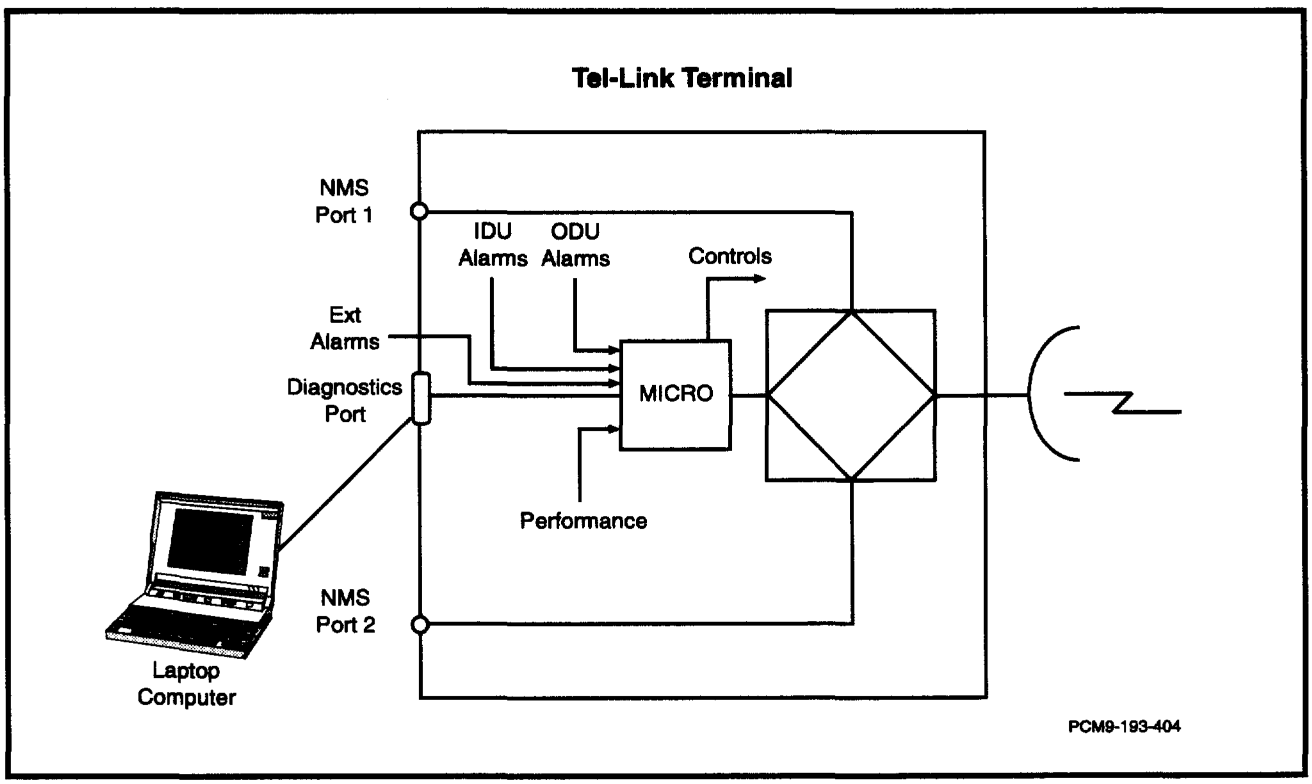


Figure 3.5 – NMS Functions



f) Capacity Upgrades:

Capacity upgrades are accomplished without any required changes in the ODU. This also allows the user to have a common ODU spare regardless of the capacity of a particular link in the network. A universal bit rate IDU is available that allows user to select either 1E1, 2E1, or 4E1 capacity through software.

g) Frequency Agility:

The ODU is frequency agile across its bandwidth. The bandwidth is determined by the channel plan, and operating frequency of the ODU as follows:

Frequency	Bandwidth
23 GHz	672 MHZ
38 GHz	560 MHz
50 GHz	250 MHz

The wider the range of frequency agility, the less system spares the user needs to stock and the more flexible the product is. All frequency changes within the range are made without requiring any access to the ODU. The IDU is the controller of this activity, whether it be by direct access to the IDU or remote control.

h) Power Attenuation:

The ODU has the capability of reducing the power output by 1 to 50 dB (1 to 30 dB on the 23 GHz radio). This is accomplished electronically from the IDU or the network management system.

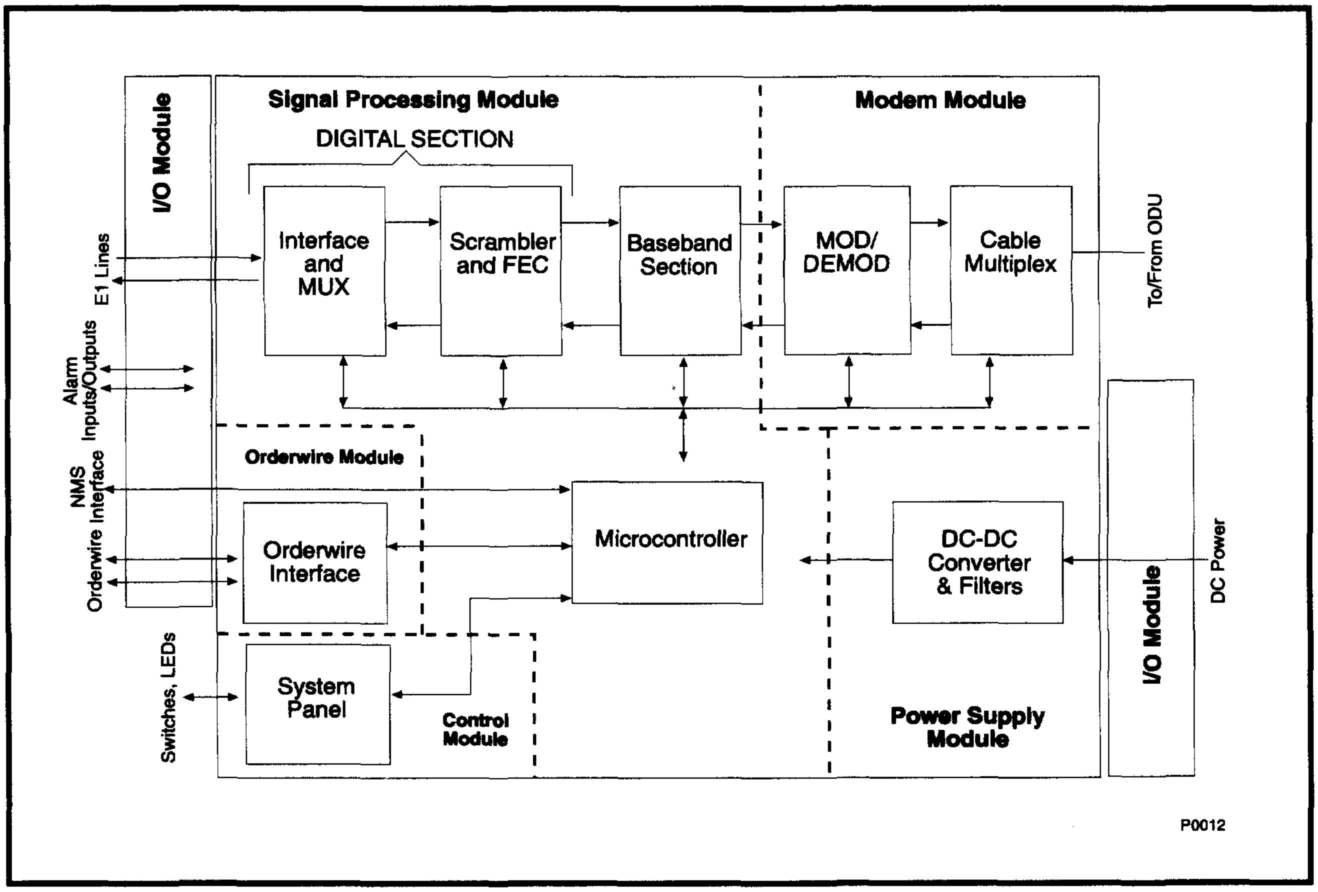
i) Alarms and Controls

The IDU possesses eight alarm inputs and five alarm outputs for customer use. These alarms appear on a 25-pin subminiature connector on the IDU. The alarm outputs are Form C relay contacts. The alarm inputs are customer defined and are typically used for environmental or site alarms. Alarm outputs are easily configured by the customer for radio alarm outputs or control outputs. This configuration takes place on the IDU front panel.

3.4 Indoor Unit (IDU)

The IDU is an indoor mounted assembly that contains all of the baseband electronics including the functions of modulation (demodulation), line interface, multiplexing (demultiplexing) and frequency generation. The IDU also includes the alarm and diagnostic interfaces, the network management interface and the frequency synthesizer control which allows the user to remotely change the RF output frequency without requiring any access to the Outdoor Unit. The IDU consists of five standard modules and one optional module. These modules are the Signal Processing Module, the Modem Module, the Control Module, the Input/Output Module, the Power Supply Module and the Orderwire Module

Figure 3.6 – IDU Block Diagram



(Optional). Figure 3.6 depicts the relationships between these modules. Figures 3.8 through 3.13 show the IDU features and options of the Basic and Enhanced versions respectively.

The primary difference between the Basic and Enhanced versions of the IDU is the addition of the keypad in the Enhanced version; features and functionality of the keypad are itemized in Figures 3.9, 3.11 and 3.13.

3.4.1 Signal Processing Module

The Signal Processing Module is separated into two distinct operational divisions, the Digital section and the Baseband section. The Digital section contains the data interface, multiplexing, scrambling and forward error correction (FEC) circuitry (optional). The Baseband section performs the baud rate generation and the clock and data recovery functions.

3.4.2 Modem Module

The Modem Module carries out the functions of transmit/receive filtering, 2-FSK (or 4-FSK) modulation/demodulation, IDU loopback and cable multiplexing. The transmit and receive IF frequencies are processed by the Modem Module which provides the physical interface to the "N" connector used to connect the IDU to the ODU.

3.4.3 Control Module

The Control Module provides the user control, internal control, maintenance and diagnostic functions, as well as status/alarm indications for the entire system. The alarm/status indications are not limited just to the IDU but include alarms/status and diagnostics for the ODU as well. Provisions are also made by the IDU microcontroller to display and relay telemetry information from the opposite end terminal.

3.4.4 Input/Output Module

The I/O Module provides all of the physical connectors for interfacing to external user equipment. These interfaces include E1 data input/output, DC power, alarm inputs/outputs, NMS, data channel and engineering orderwire. The architecture of the Tel-Link Radio allows for the I/O Module to mount either on the front or the rear of the IDU. This allows a "front access only" unit for those installation environments where it is difficult to access the rear of the installed equipment.

3.4.5 Power Supply Module

The Power Supply Module supplies the voltage, current, and protection necessary to power the various circuits that are resident part of the Indoor Unit. The Power Supply Module also transfers -48 VDC to the cable multiplexer circuitry on the Modem Module. This -48 VDC is used to power the ODU via the interconnecting coaxial cable. An optional ±24 VDC power supply module is available.

3.4.6 Orderwire Module (Optional)

The optional Orderwire Module provides the user with a VF interface for voice communication between the local and remote site during installation, commissioning and maintenance. The added overhead required to accommodate the orderwire information is multiplexed in with the primary data stream and does not affect the transmission of the user's E1 inputs/outputs. The physical interface to the user is an RJ-11 type telephone jack.

3.4.7 Service Channels

The Tel-Link Radio provides three service channels for customer use.

The first service channel is a VF engineering orderwire. The orderwire has three ports, each possessing a RJ-11 phone jack on the IDU front panel for physical interface. The first phone jack is a handset port only. The other two phone jacks are interfaces to, 600 ohm, east and west, bridged ports. The bridged ports can be used to distribute the orderwire channel at junction sites. The same two bridging ports can also be connected to an external orderwire panel.

The second service channel is a 64 kb/s oversampled serial data channel that provides up to 9600 b/s digital data interface for customer use. No data rate selection is required; the user merely injects a signal of any speed, up to 9600 b/s. There are two, east and west, bridged ports. The user may use one at a terminal site or use both ports for daisy chaining the data channel at junction sites. The data ports appear at two 9-pin subminiature connectors on the IDU. RS232 and RS422/423 interfaces for each port appear at the 9-pin subminiature connectors.

The third service channel is a 64 kb/s oversampled serial Network Management System (NMS) channel that provides up to 9600 b/s NMS interface. No data rate selection is required; the user merely injects a signal of any speed, up to 9600 b/s. There are two, east and west, bridged ports. The user may use one at a terminal site or use both ports for daisy chaining the NMS channel at junction sites. The data ports appear at two 9-pin subminiature connectors on the IDU. RS232 and RS422/423 interfaces for each port appear at the 9-pin subminiature connectors. The NMS channel can carry the P-Com protocol or can be customised to a specific user interface requirement. By muting the microprocessor signal from the Signal Processing Module, the customer can configure the NMS channel to carry any external network management or supervisory signal, provided the signal meets RS232 or RS422/423 interface requirements.

3.4.8 Keypad and LCD Display (Enhanced IDU only)

The keypad and LCD display are located on the front panel of the Enhanced version of the IDU. The keypad, a versatile instrument, is a local interface to the Tel-Link Radio. The keypad is used for entering local, remote and system operational parameters. The display echoes the entry of these parameters. The display also automatically indicates local, remote and system alarms.

The following configuration items can be entered via the keypad:

- RF operating frequency
- RF power output
- Orderwire address
- NMS address
- Link ID
- Loopback
- Alarm relay monitor points

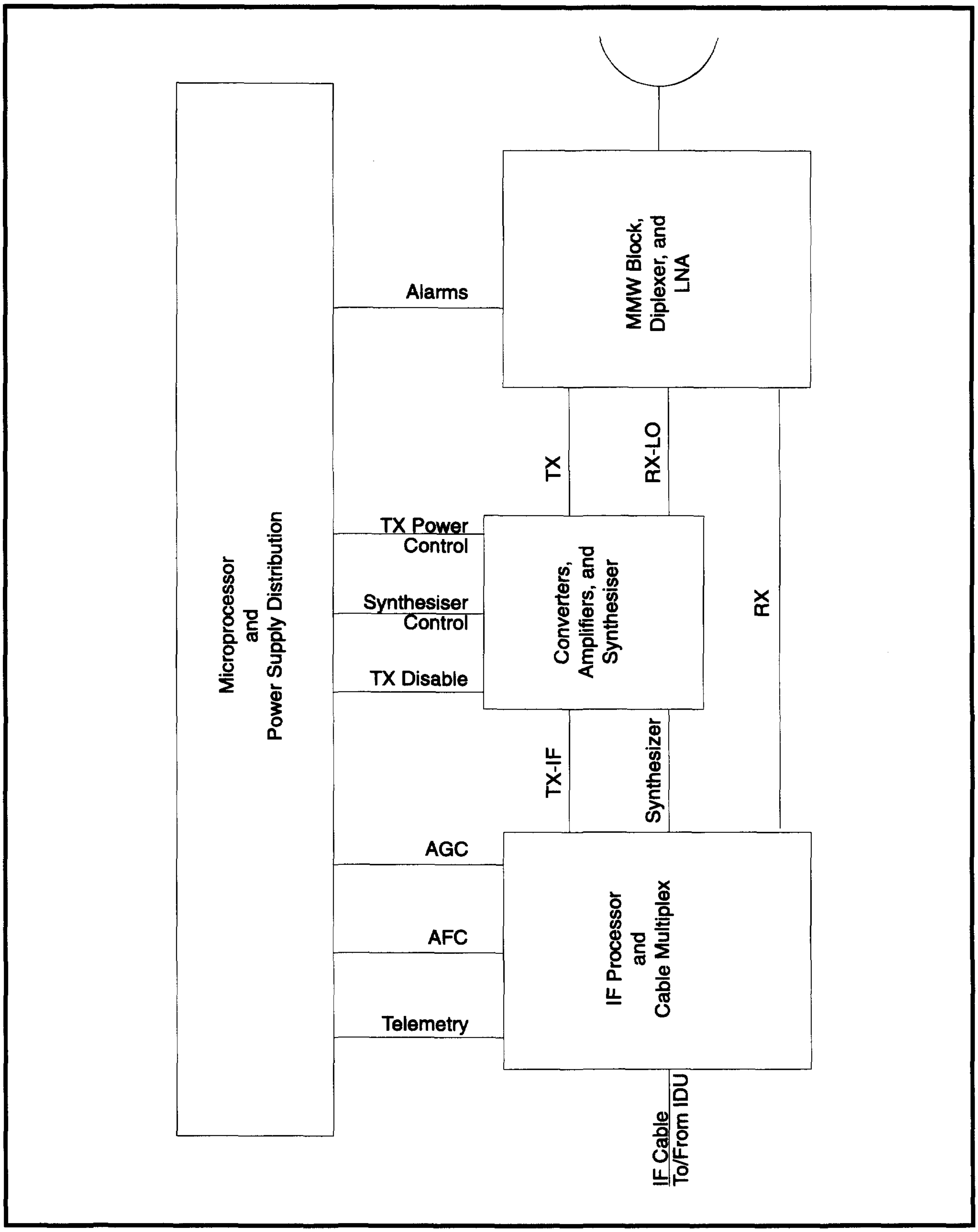
The following parameters can be monitored from the keypad and LCD display:

- BER
- RSL
- DC input power
- Alarms (local and remote)

3.5 Outdoor Unit (ODU)

The ODU is a millimetre wave RF assembly that operates in conjunction with the IDU unit. The ODU is lightweight (4.5 kg) and compact. It is fitted with an integrally mounted antenna assembly 30 or 60 cm in diameter. The ODU is designed for outdoor mounting on a tower, roof top, wall-mount or other suitable structure. The ODU is connected to the IDU by means of a single coaxial cable. The coaxial cable interface provides the IF signal and power to the ODU. The primary function of the ODU is to upconvert the IF signal from the IDU to the desired millimetre wave RF output for transmission to the opposite terminal, and to downconvert this signal to the IF product at the receiving terminal. Refer to Figure 3.7 which shows the ODU in block schematic form.

Figure 3.7 - ODU Block Diagram



3.6 Tel-Link Series Radio Equipment Specifications:

General:

Capacities	1 x 2.048 (1E1), 2 x 2.048 (2E1), 4 x 2.048 (4E1) Mb/s
RF Channel Spacing	2-FSK: 1E1 & 2E1 - 7 MHz, 4E1 - 14 MHz 4-FSK: 1E1 & 2E1 - 3.5 MHz, 4E1 - 7MHz
Digital Line Input/Output	BNC 75 Ohm Unbalanced, 120 Ohm Balanced Option
Digital Line Code	HDB3
Modulation Type	2-FSK or 4-FSK
Frequency Source	Synthesizer
RF Channel Selection	Via IDU Keypad, or NMS
System Configurations	Non-Protected (1+0), or Monitored Hot Stand-by (1+1)
Loopbacks	IDU, ODU, Link, Line

Service Channels:

Number of Channels	Three	
Available Configurations	Engineering Orderwire (S.C. #1)	300-3400 Hz
	Digital Data channel (S.C. #2)	0-9600 bit/s
	NMS/Data channel (S.C.#3)	Customised
User Interfaces	Engineering Orderwire	RJ-11
	Data Channel & NMS	RS-232C, RS-422/423

Mechanical:

Dimensions	
Outdoor Unit	250 mm dia, 200 mm depth (10" dia, 8" depth)
Indoor Unit	89 x 483 x 267 mm (3.5" x 19" x 10.5") H x W x D
Weights	
Outdoor Unit	4.5 kg (10 lbs)
Indoor Unit	3.6 kg (8 lbs)
IDU to ODU Interconnection	
No. of Cables	One (1) coaxial cable
Distance	Up to 300 meters (1000 feet)
Recommended Cable	Belden 9913 (RG-8/U type) or equivalent
Connector Type	"N" Male

Environmental:

Temperature Range	
Outdoor Unit	-30° to +60° C
Indoor unit	-10° to +55° C
Relative Humidity	
Outdoor Unit	Up to 100% (all-weather operation)
Indoor Unit	95% at +55° C
Altitude	4,500 meters (15,000 feet)
Storage	-40° to +70° C

Power Requirements:

Voltage Input	-48 VDC
Optional Voltage Input	+/-24 VDC
Power Consumption	
E1	35 Watts
2E1	35 Watts
4E1/Universal	40 Watts

Frequency Specific Parameters:

	Tel-Link 23	Tel-Link 38	Tel-Link 50
Frequency Range (GHz)	21.2 - 23.6	37.0 - 39.6	49.2 - 50.2
Transmitter to Receiver Spacing	1232 MHz 1008 MHz 1274 MHz	1260 MHz	500 MHz
Synthesizer Tuning Range	672 MHz*	560 MHz	250 MHz

* Depending on Option and Channel Plan

	Tel-Link 23	Tel-Link 38	Tel-Link 50
Transmitter			
Power Output (standard)	+17 dBm	+17 dBm	+8 dBm
Power Output (optional)	+22 dBm	N/A	N/A
Frequency Stability	+/-0.0005%	+/-0.0005%	+/-0.0008%
Attenuation Range	0-30 dB	0-50 dB	0-50 dB
Receiver			
Type	Dual Conversion		
Intermediate Frequency	140 MHz		
Unfaded BER (no FEC)	1 x 10^{-11} or better		
Unfaded BER (with FEC)	1 x 10^{-13} or better		

System Gain:

	Tel-Link 23 SP/HP*	Tel-Link 38	Tel-Link 50
Sensitivity for 1x10^{-6} BER (no FEC)			
1E1	-86 dBm	-84 dBm	-81 dBm
2E1	-83 dBm	-81 dBm	-78 dBm
4E1	-80 dBm	-78 dBm	-75 dBm
Sensitivity for 1x10^{-6} BER (with FEC)			
1E1	-89 dBm	-87 dBm	-84 dBm
2E1	-86 dBm	-84 dBm	-81 dBm
4E1	-83 dBm	-81 dBm	-78 dBm
Sensitivity for 1x10^{-3} BER (no FEC)			
1E1	-89 dBm	-87 dBm	-84 dBm
2E1	-86 dBm	-84 dBm	-81 dBm
4E1	-83 dBm	-81 dBm	-78 dBm
Sensitivity for 1x10^{-3} BER (with FEC)			
1E1	-91 dBm	-89 dBm	-86 dBm
2E1	-88 dBm	-86 dBm	-83 dBm
4E1	-85 dBm	-83 dBm	-80 dBm
System Gain for 1x10^{-6} BER (no FEC)			
1E1	103/108 dB	101 dB	89 dB
2E1	100/105 dB	98 dB	86 dB
4E1	97/102 dB	95 dB	83 dB
System Gain for 1x10^{-6} BER (with FEC)			
1E1	106/111 dB	104 dB	92 dB
2E1	103/108 dB	101 dB	89 dB
4E1	100/105 dB	98 dB	86 dB
System Gain for 1x10^{-3} BER (no FEC)			
1E1	106/111 dB	104 dB	92 dB
2E1	103/108 dB	101 dB	89 dB
4E1	100/105 dB	98 dB	86 dB
System Gain for 1x10^{-3} BER (with FEC)			
1E1	108/113 dB	106 dB	94 dB
2E1	105/110 dB	103 dB	91 dB
4E1	102/107 dB	100 dB	88 dB

*23 GHz System Gain Values Are listed With "Std/High" Power Configurations

Antenna Parameters:	**Tel-Link 23**	**Tel-Link 38**	**Tel-Link 50**
Diameter	30 & 60 cm	30 & 60 cm	30 cm
Gain (30 cm)	34 dBi	38 dBi	39 dBi
Gain (60 cm)	40.5 dBi	44 dBi	N/A
3 Degree Beamwidth (30 cm)	3.2	1.6	1.6
3 Degree Beamwidth (60 cm)	1.5	0.8	N/A
Polarisation	Vertical or Horizontal		
Radiation pattern Envelope	High Performance		
Elevation Adjustment	+/-20° Coarse, +/-10° Fine		
Azimuth Adjustment	+/-180° Coarse, +/-10° Fine		
Standard Mounting	44 mm - 114 mm OD Pole (1.75" - 4.5")		
Windloading	50 m/s (112 mph) Operational 70 m/s (157 mph) Survival		

Specifications reflect typical performance, are subject to change without notice, and apply to equipment connected back-to-back unless otherwise noted.

3.7 Features and Benefits

P-Com's design approach has resulted in a product architecture that has diverged from the conventional millimetre design. The P-Com second generation design will allow the Tel-Link Radio user to realise operational advantages over users of first generation equipment. Designed-in features such as the highly integrated ODU and the one-cable configuration between the IDU and ODU assemblies are just two examples of the cost-saving features that will allow the user to operate the system easily, efficiently and reliably.

Feature	Benefit
	Low Cost of Ownership
Capacity, RF power, and RF frequency changes at IDU	Customer can upgrade system without climbing tower
Built-in diagnostics	Customer can view station, link and system parameters from one location
ODU frequency commonalty	Easy system sparing
Highly integrated RF electronics	High ODU reliability
	Low Cost of Installation
No post-factory alignment or testing of radio units	Quick and easy link turn-up
No special tools	Simple installation
One cable between IDU and ODU	Quick, simple installation Higher reliability

Note: Features shown with dashed lines indicate an option.

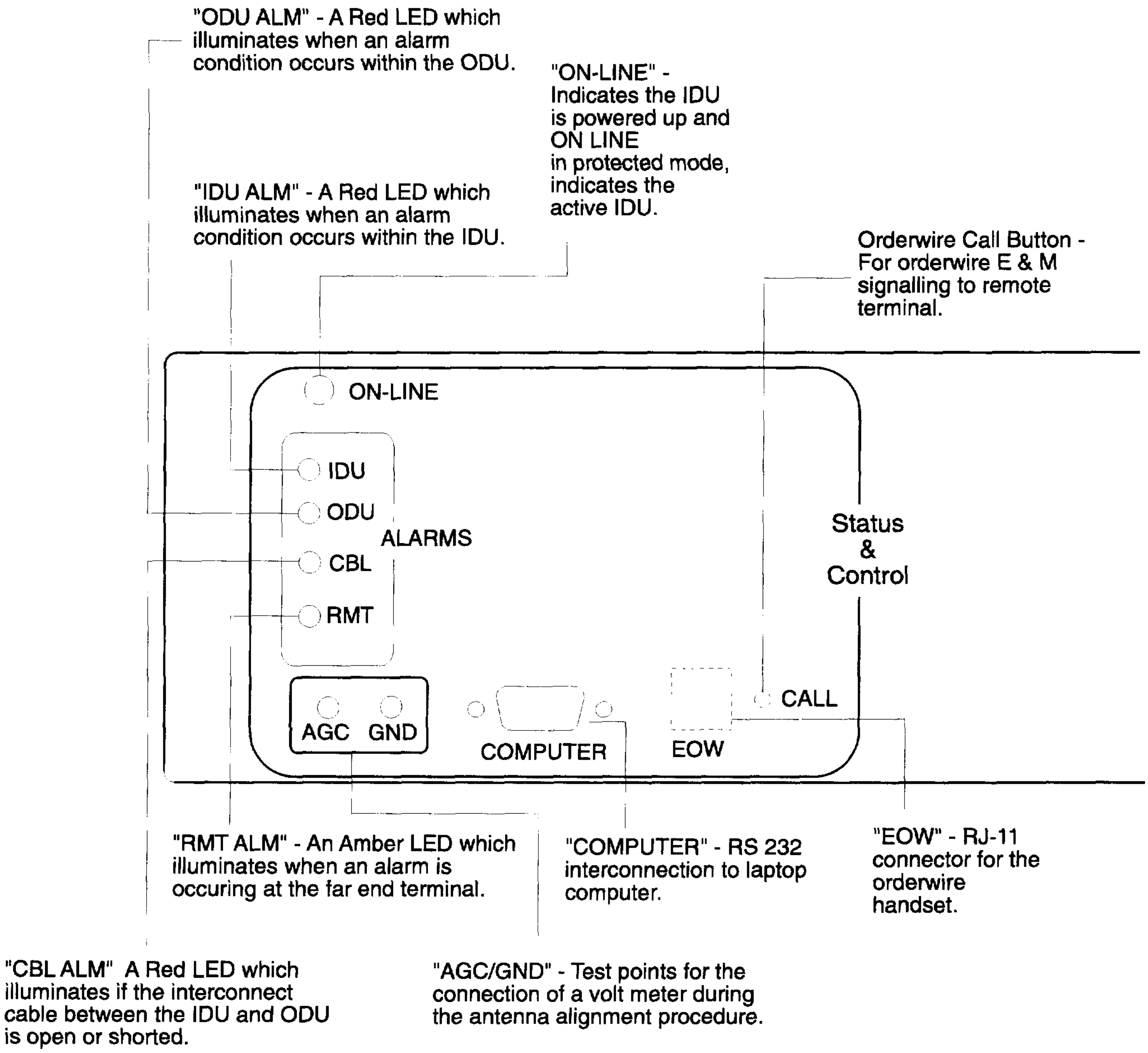
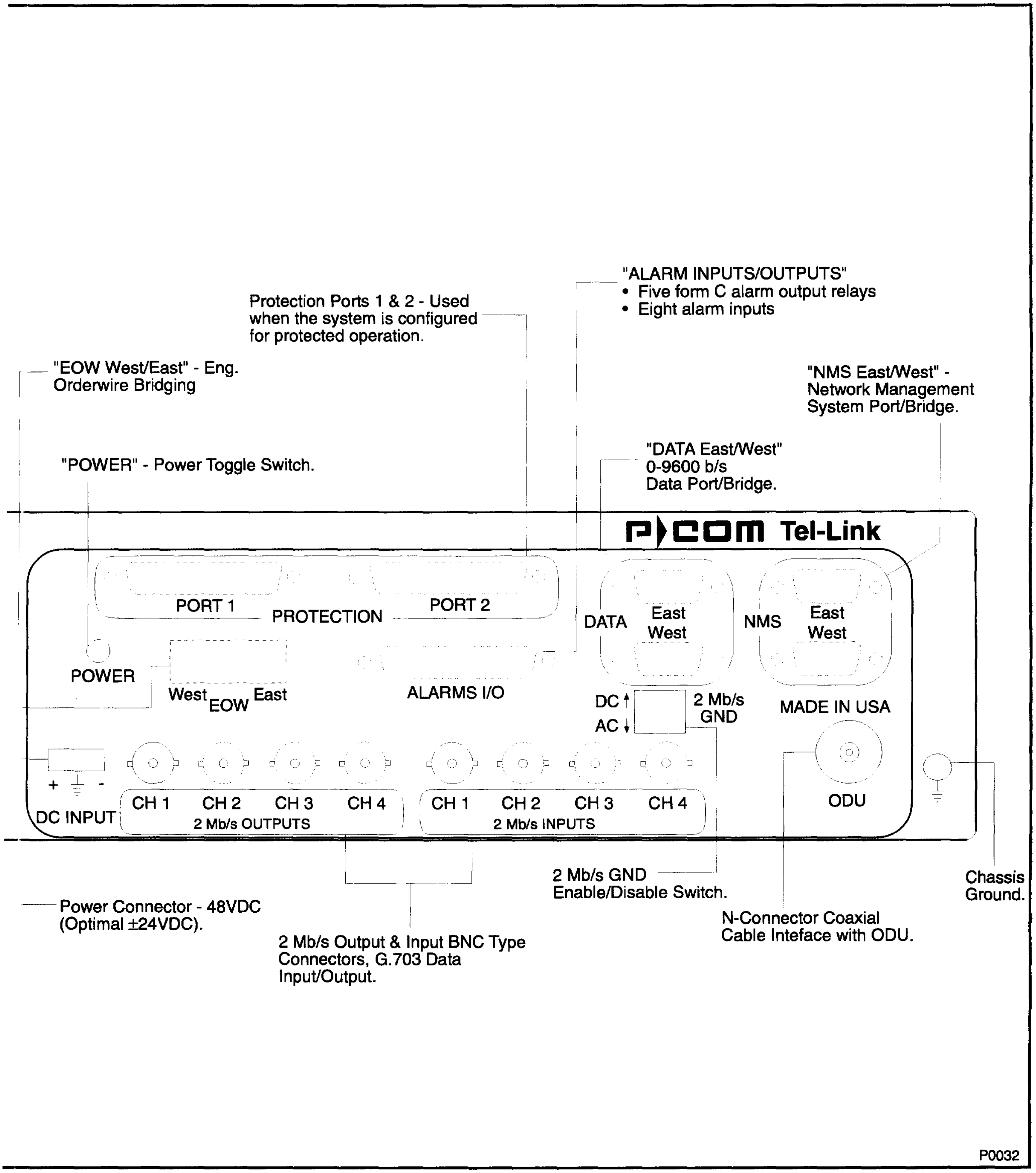


Figure 3.8 - Indoor Unit (IDU) Front Panel Features, Basic Version with 75 Ohm Data Interface



Note: Features shown with dashed lines indicate an option.

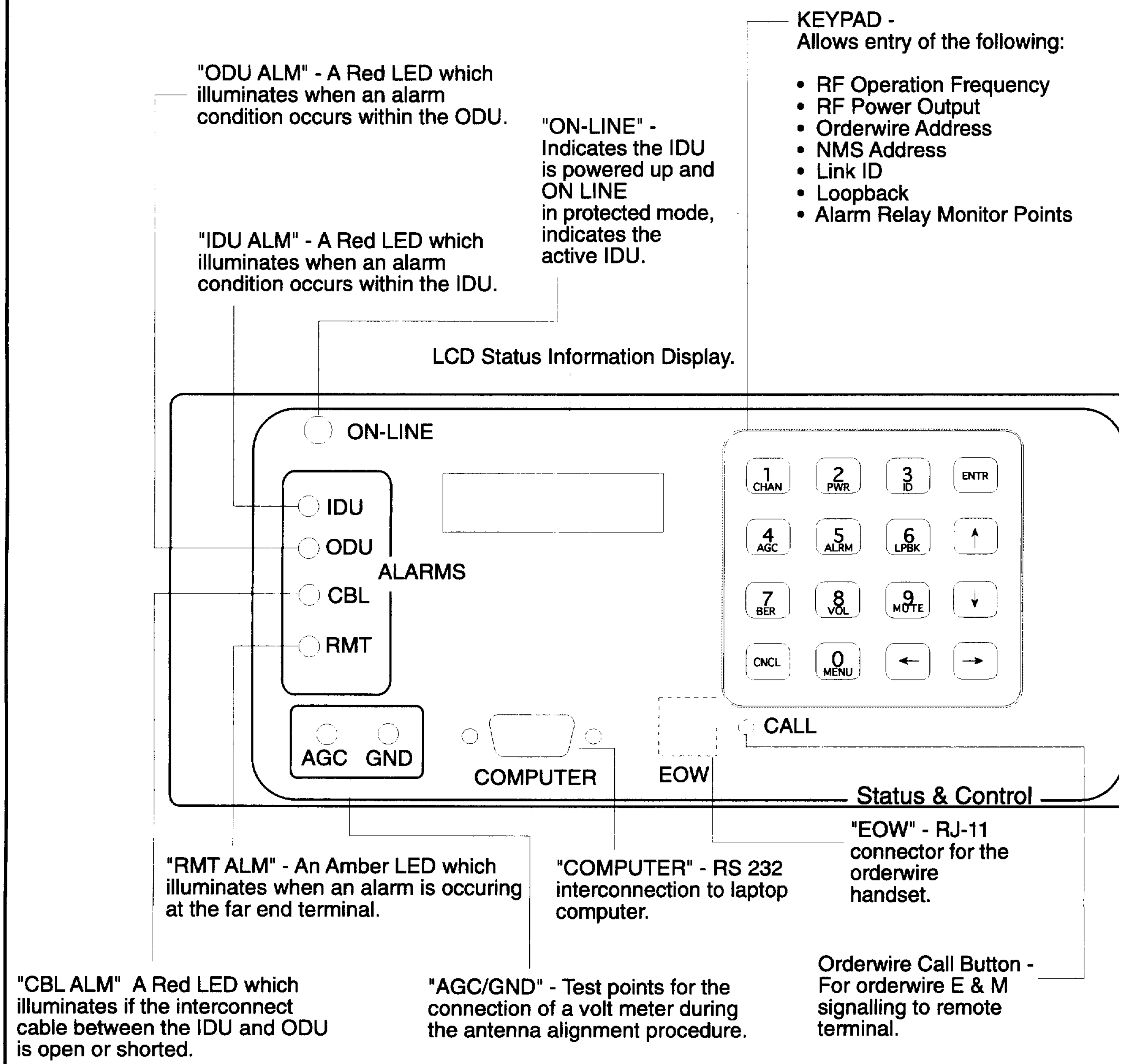
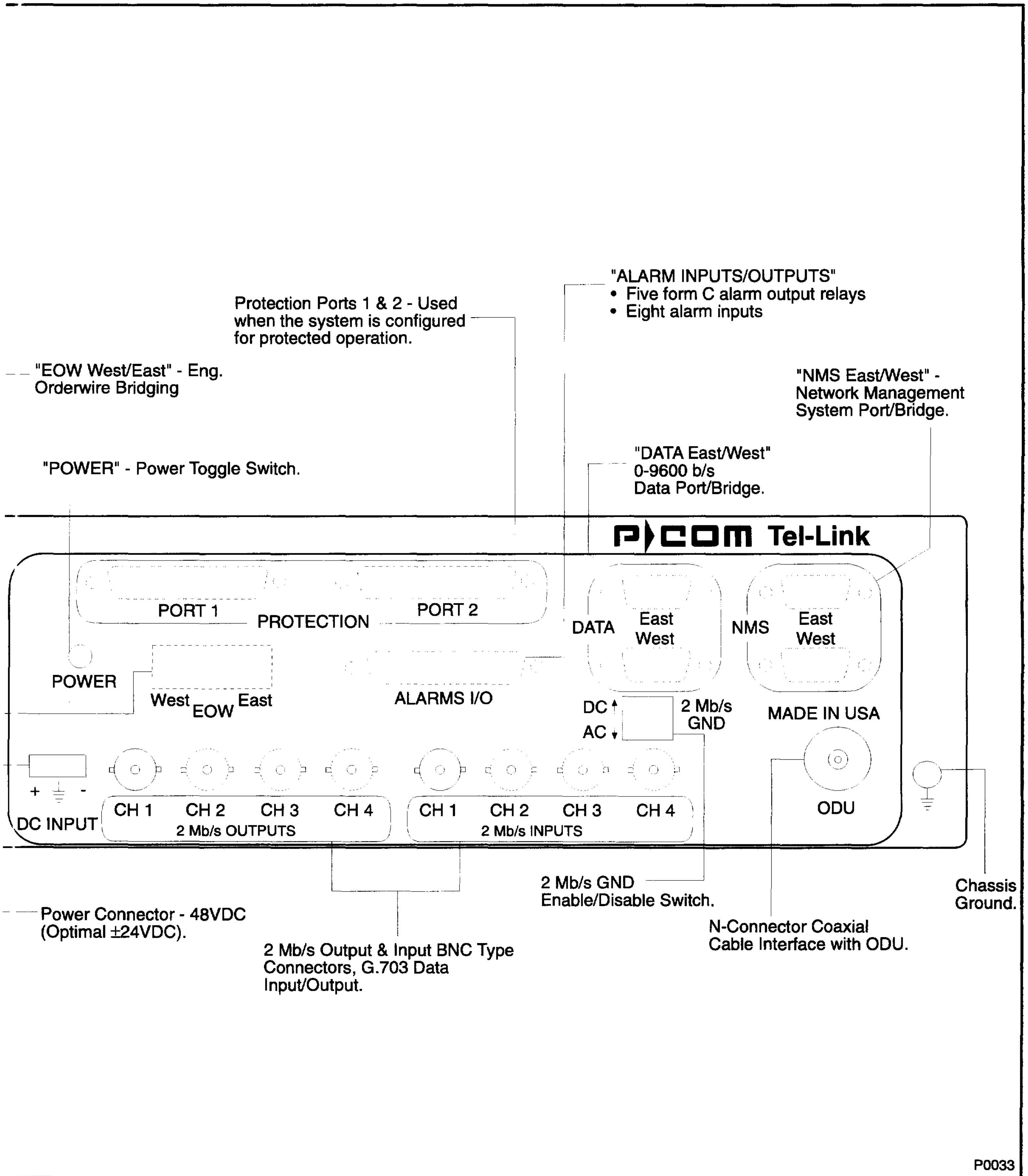


Figure 3.9 - Intdoor Unit (IDU) Front Panel Features, Keypad Version with 75 Ohm Data Interface

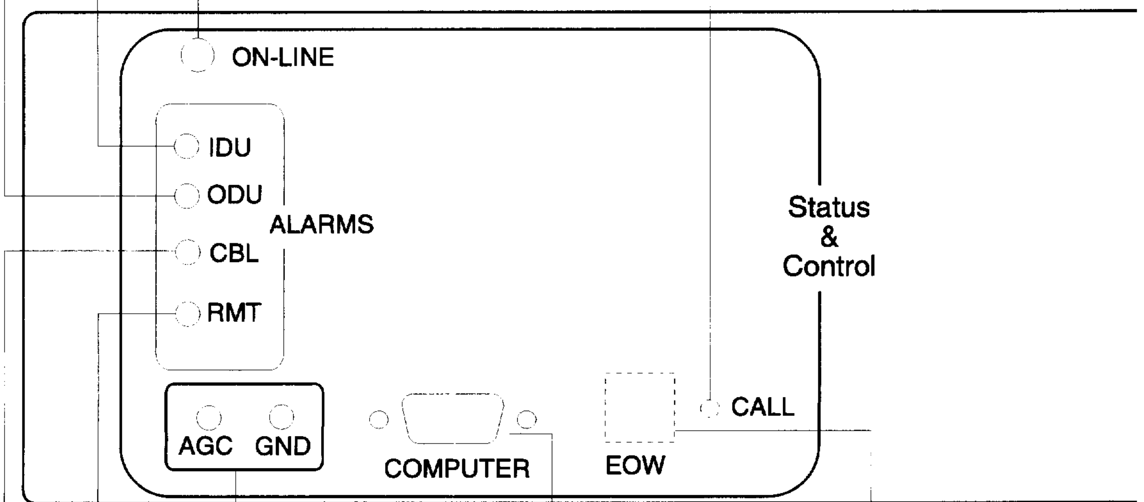


"ODU ALM" - A Red LED which illuminates when an alarm condition occurs within the ODU.

"ON-LINE" - Indicates the IDU is powered up and ON LINE in protected mode, indicates the active IDU.

"IDU ALM" - A Red LED which illuminates when an alarm condition occurs within the IDU.

Orderwire Call Button - For orderwire E & M signalling to remote terminal.



"RMT ALM" - An Amber LED which illuminates when an alarm is occuring at the far end terminal.

"COMPUTER" - RS 232 interconnection to laptop computer.

"EOW" - RJ-11 connector for the orderwire handset.

"CBL ALM" A Red LED which illuminates if the interconnect cable between the IDU and ODU is open or shorted.

"AGC/GND" - Test points for the connection of a volt meter during the antenna alignment procedure.

Power Connector - 48
(Optimal ±24VDC).

Note: Features shown with dashed lines indicate an option.

Figure 3.10 – Indoor Unit (IDU) Front Panel Features, Basic Version with 120 Ohm Data Interface